

Harnessing Internet and Intranet Technology for Oil Analysis

John H. Jones

Rick Wheeler

Atlanta Systems Consultants, Inc.

2814 Spring Road

Atlanta, GA 30339

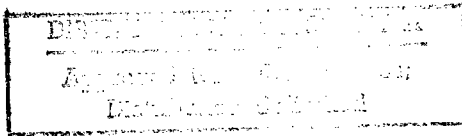
Voice (770) 432-9856

Fax (770) 801-9079

Email: jhjones@asclink.com

rwheeler@asclink.com

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Abstract: The incorporation of Internet/Intranet technology into used oil analysis laboratories provides cost-effective, powerful solutions for operational needs and customer requirements. An Internet-based application also has reduced requirements for development, deployment, and maintenance when compared to client-server systems. Also, Internet/Intranet technology can coexist with existing client-server systems, providing to the laboratory enhanced and expanded functionality to support changing requirements. Laboratories can realize the power of Internet/Intranet technology in two major areas. First, Internet-based laboratory applications provide a dynamic mechanism for information distribution to customers. Delivery of analysis reports by fax, mail, and BBS is replaced by e-mail delivery and on-demand information access by customers. Since many oil analysis customers are very mobile, remote access to their information via Internet technologies such as e-mail and laboratory websites offers a significant benefit to the customer. Second, with an Internet-based application accessed via the Internet or a corporate Intranet (a private model of the Internet), samples can be received and tested at any number of remote sites with the information transferred to the central laboratory database via the Internet-based application. The central location can access the same central laboratory database and develop sample analysis and evaluation reports for distribution to customers.

Key Words: Client-server; Internet; Internet-based application; Intranet; laboratory database; oil analysis; on-demand access; remote access.

Introduction: In discussing the benefits of implementing Internet technology to improve laboratory operations, we must first define the technology components of which we speak. We will assume at this point that the reader has at least a minimal understanding of what the Internet is. The components which we see as being used in an Internet-based application include World-Wide Web pages (screens), e-mail (electronic mail), and FTP (file-transfer protocol). These components represent ways for users to retrieve information from or deliver information to an Internet server. In order to offer these services to users who connect to an Internet server, the server must have special programs

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running. To deliver information via web pages or FTP, the server must run software like Microsoft Internet Information Server. This software equips the server to deliver and receive files via FTP, display web pages to users, and receive web page input from users. Software such as Microsoft Exchange Server allows the server to receive and deliver e-mail messages.

For the client end of these transactions, the user needs only two software components. The first component is a 'web browser'. A web browser is a program which is designed to receive pages from an Internet server and display them. In addition, this program allows the user to input information into a web page and send the information back to the server. The most recognized examples of a web browser are Microsoft Internet Explorer and Netscape Navigator. In addition to displaying web pages, the web browser can also facilitate file download from a server or upload to a server via FTP. The second software component is an e-mail program. This program allows the user to receive e-mail messages and send e-mail messages, and even both with files attached. The installation of a web browser and an e-mail program are the extent of components required on the client (user's) machine.

An Internet-based application is more than just a website. Websites are predominantly designed to deliver information to users with very little input back to the server. In contrast, an Internet-based application is designed for accommodating interaction between the user and the server to accomplish tasks such as entering sample test results. We have previously discussed two software components on the Internet server. In order to interface with laboratory data, a database server component is required. This component will provide laboratory data in the web pages requested by the user as well as receive and store input from the user. An example of a database server component would be Microsoft SQL Server or Oracle. The Internet-based application communicates to the database server component via an ODBC (Open Database Connectivity) connection. By using an ODBC connection, the Internet-based application can interact with any database server which is ODBC-compliant.

While we continue in this discussion to refer to an Internet server, this does not mean that the server is connected to the Internet. It means that the server functions like the Internet server model. A server can be connected to a corporate local area or wide area network and not be accessible by anyone not connected to the corporate network. This picture of an Internet server and client workstations connected to a network is the definition of a corporate Intranet. It functions identical to the Internet model, yet users not connected to the corporate network cannot access the server's information.

In the following sections, we will discuss two areas where these technology components we have identified can be implemented to serve the needs of an oil analysis laboratory.

Serving The Laboratory: In order to address how Internet/Intranet technology can support the needs of an oil analysis laboratory, we must first identify the major processes.

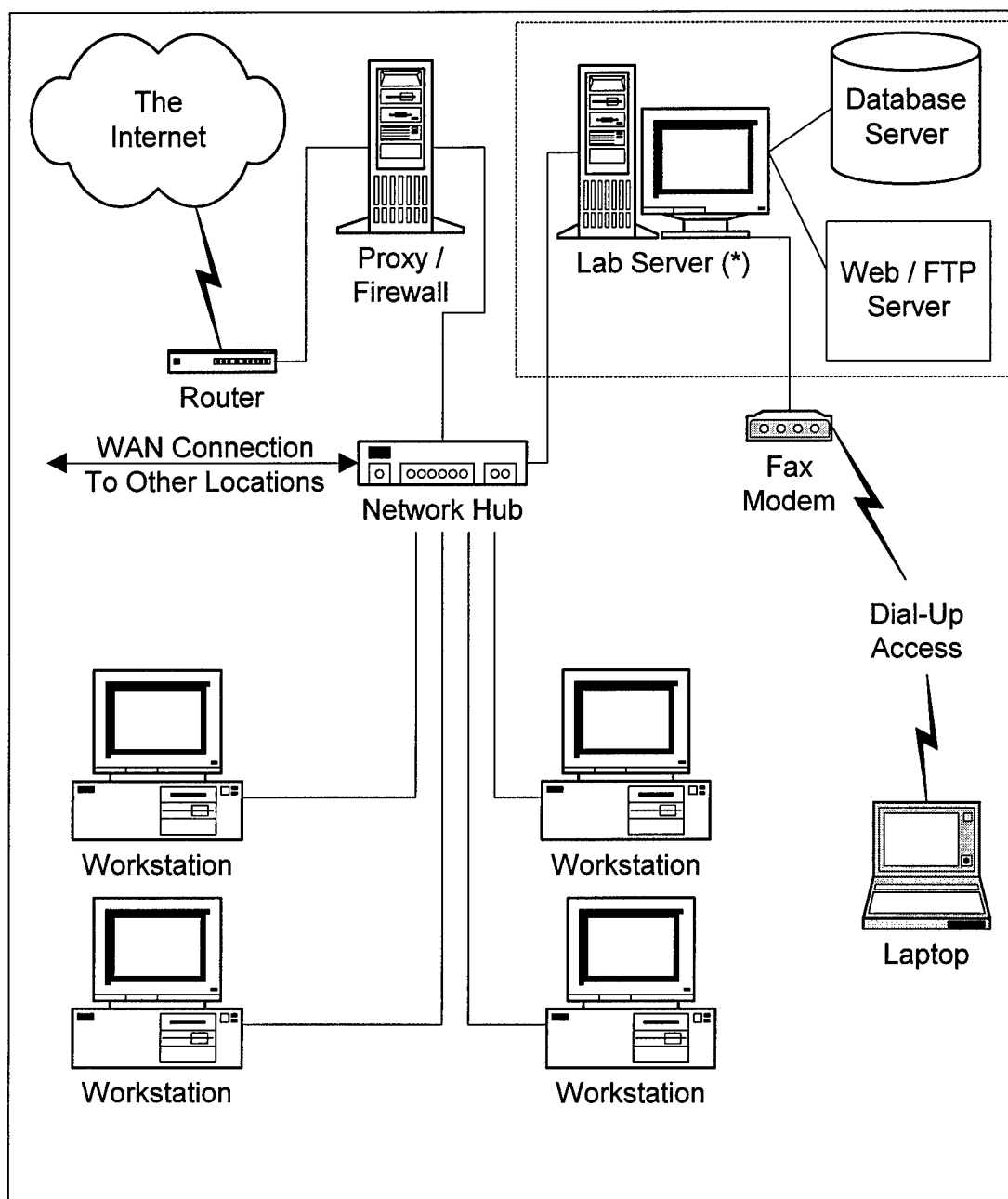
1. Sample Receiving & Logging
2. Sample Testing
3. Sample Test Data Entry
4. Sample Data Evaluation
5. Analysis Report Development
6. Report Distribution

While not directly part of the workflow described, Administration of users and reference information is also a necessary component of laboratory operations. Processes for interaction with accounting or other business systems are not listed here, but this does not mean that Internet/Intranet technology can be beneficial in these other areas as well.

An Internet-based application can be implemented in one of several ways. If there is no existing Laboratory Information Management System (LIMS) in place, an Internet-based application can perform all of the necessary LIMS functionality. This application would encompass the needs of the processes listed above as one cohesive application. In those cases where a LIMS exists, an Internet-based application can coexist with the LIMS, providing expanded and enhanced functionality while interacting with the LIMS database. An Internet-based application is a framework of individual pages (or screens) which are connected together by logic and hyperlinks to other pages. A hyperlink is a listing of another page's name or topic which, when selected by the user, moves the user to the selected page. Each page of an Internet application is a self-contained unit; it can be managed and updated as an individual file. For this reason, keeping the application up to date with the changing needs is much easier than with traditional client-server applications. In traditional client-server applications, the application must be taken off-line, modified, compiled, and the installation on each client updated. During this time, the application is unavailable to all users. With an Internet application, a new version of single page can be prepared and deployed while users continue to run the application. Once the page has been revised and deployed, the next user to access that page gets the revised functionality immediately without any client software updates required. This granularity of the application allows the laboratory to make and deploy modifications quickly without interrupting current activities.

A traditional multi-user client-server application for a laboratory interacts with a laboratory database to store and retrieve information. A database server access license is required for each client (user) running the application. The cost for a large quantity of database licenses can be significant. Further, each workstation added must have the software installed for the application. With an Internet-based application, the number of concurrent users is solely limited by the server capacity. The Internet-based application interacts with the laboratory database as an intermediary, requiring only one database license regardless of the number of concurrent users. This means that adding more users to an Internet-based application requires only the workstation hardware along with a web browser. The Internet-based application resides on the server.

Internet-based applications are fully capable of receiving bar coded information as user input for sample receiving and sample identification. The application is capable of full interaction with the laboratory database via the pages presented to the user. In an Internet-based application, it is possible to develop spreadsheets with intrinsic formulae and calculations as needed for test data entry and data validation. Spreadsheets can also be developed for data analysis and evaluation. The spreadsheet format can also be used for analysis reporting with intrinsic graphs and charts based on the reported data. These user-defined spreadsheets can be easily integrated into the application user interface.



With an Internet server, analysis reports can be distributed in the traditional ways of printed reports delivered by mail and by manually-initiated fax. Beyond this, an Internet-based application can automate the process of report distribution. Reports can be automatically delivered to printers and fax machines. In addition, report information can be automatically delivered as e-mail messages or as files attached to e-mail messages. Reports can also be delivered to an FTP site on the Internet server; the customer can then download the reports at their convenience.

Because the application is designed as an Internet application, it is inherently multi-user. Because the application resides on an Internet server connected to the corporate network, it is available to all users who are connected to the corporate network. A corporate wide-area network specifically connects together multiple geographic locations of a company. The Internet application is accessible to all locations of the wide area network. Dial-up access can be established to the Internet server and the Internet server can be connected to the Internet through a dedicated Internet connection. What does all this mean? It means that a laboratory operation can be comprised of multiple geographic locations connected together as one laboratory enterprise. Samples can be received, logged and tested at various remote locations with either wide-area network, dial-up or Internet connection to the application. The data is entered into the application and is available to analysts in a central location where the laboratory database is located. The evaluation is performed and the results are automatically delivered by fax, e-mail or ftp.

What is required to implement an Internet-based application? The diagram on the previous page illustrates the requirements. In order to implement a multi-user Internet-based application, the first requirement is a network infrastructure. This is the wiring which connects all of the workstations and servers to a hub or set of hubs. This is commonly referred to as a network. If the network is a LAN (local area network), then only computers in a single geographic location are connected together. If the network is a WAN (wide-area network), then there is a connection from the hub in one location to a hub in another location. In either case, all the computers connected to the network are viewed as one enterprise. The second requirement is the implementation of a server or servers for the laboratory. The two components on the server(s) are a database server program and an Internet server program (for web/ftp). These components can be implemented on the same server or on separate servers as desired. If there is an existing e-mail system, the Internet server requires an account on the e-mail system in order to be able to deliver information automatically by e-mail. If there is no existing e-mail system, the Internet server will need an E-mail server program such as Microsoft Exchange Server. Workstations require only web browser software; e-mail software is optional.

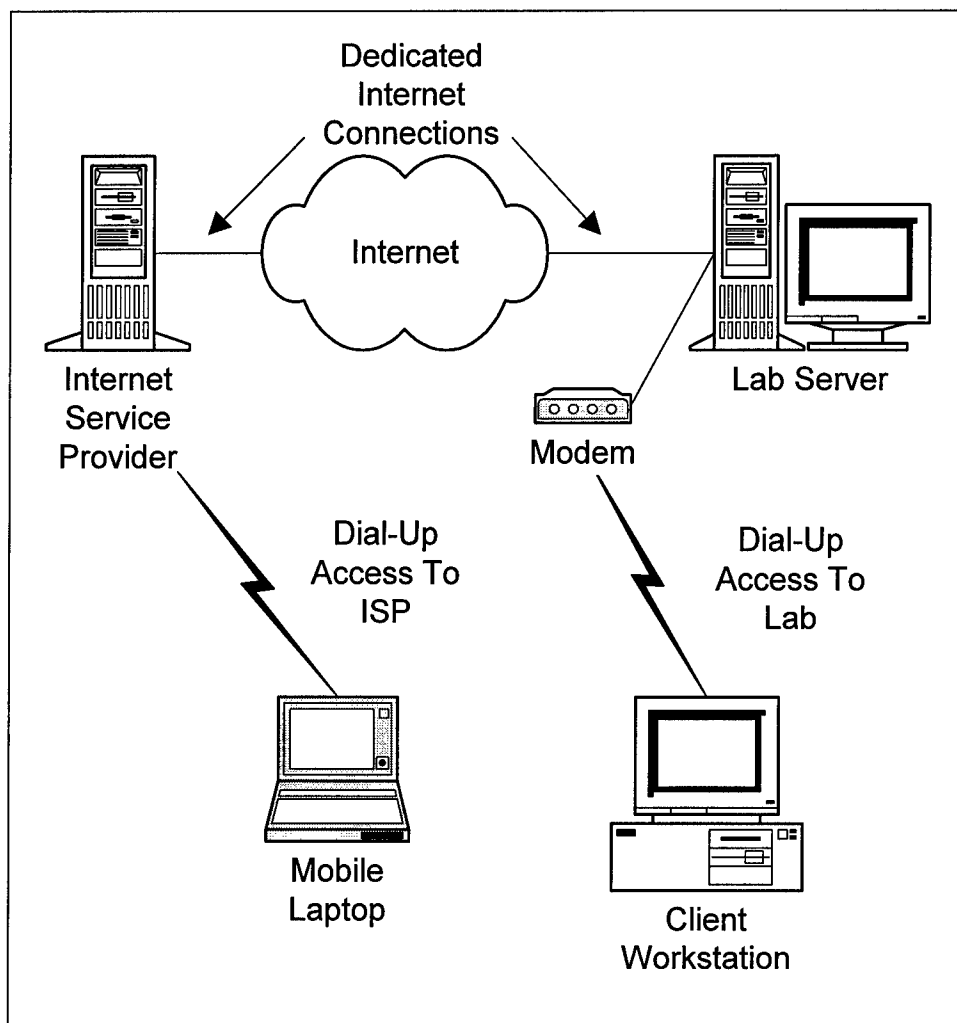
In order to support server access by remote (to the network) users, there are two options. A modem connected to the Internet server can provide dial-up access to the Internet-based application through Remote Access Services. The second option is to establish a dedicated Internet connection. This option requires a dedicated connection to an Internet Service Provider (ISP), typically by ISDN phone line or leased line. This line is connected to a router, which is in turn connected to a proxy or firewall server. The proxy/firewall server provides controlled access via the Internet to protect the overall

system from unwanted intrusion. The output of the proxy/firewall server is connected to the existing network hub. This completes the circuit from remote users to the Internet server for access to the application. For remote users, it is acceptable to support both Internet and Dial-Up access.

What are the benefits of implementing an Internet-based application? The application is constructed in such a way that the number of users has no significant impact on performance and increasing the number of concurrent users has no cost impact on database server licensing. Adding additional workstations requires only an operating system and a web browser; no other software installation is required. The application has the granularity of each individual page. Pages can be updated or modified with industry-standard tools and deployed without taking the system off-line. New pages can easily be added without negatively impacting existing pages or systems. The required skill level of those who would modify or maintain the application is significantly lower than any other client-server system approach. The application can be developed to extend existing laboratory processing capabilities without impacting existing systems. The laboratory can work as one enterprise even though users are not necessarily located in one geographic location. Remote users all over the world can work effectively as part of the same enterprise.

Serving The Customer: This is an area where an Internet-based application provides tremendous potential benefits. The customer has a number of needs associated with laboratory information. One need is the ability to track samples that have been sent for analysis. They need to know if and when the sample has been received and if the analysis information is available. The customer needs to be able to receive results regardless of their current geographic location, mobile or stationary. The laboratory does not need to spend any time or effort in making the customer's information accessible. Laboratories are not in the business of developing, distributing, and supporting software for customer access to results. Any time spent on this is counterproductive to laboratory profitability and throughput. In this vein, it is important to offer a solution which eliminates any special remote access software from being used by the customer. At the same time, the customer needs the ability to generate hard-copy reports on-demand. The customer needs to be able to have more input into the processing of his samples. In some cases, this means making requests for additional tests or different reporting formats. The customer needs to have the ability to change the priority of individual samples sent for analysis. The customer needs to be able to identify in advance that a sample requires special handling or turnaround time prior to the sample being received by the laboratory.

An Internet-based application has the potential to address each and every one of these needs and more. The application for the laboratory can have specific pages designed for customer access. These pages would control where in the application the customer can go and what they can access. Essentially, the customer could become a remote member to the laboratory enterprise. The customer could connect to the application either through the Internet or through dial-up access to the Internet server. The diagram on the following page illustrates the possible connection paths.



If the customer is only going to receive laboratory information via e-mail, then the customer only has to connect to their Internet Service Provider and poll for e-mail messages. If the customer requires more direct access to the laboratory information, they would connect as a remote user as indicated in the diagram and login to the laboratory system. Once the customer has connected as a remote user and logged in to the laboratory application, the application has full control of the access and information provided to the customer. At this point, the customer can begin to act as an integral part of managing sample information. The customer can fill out requests for sample processing or order sample kits on-line. In filling out requests for samples, the customer can perform data entry on some items that now are being filled out by hand by the customer and manually transcribed by sample receiving personnel.

Because customers could connect to the 'live' system, information to which they are granted access is always current; there is no delay between posting of analysis information and the customer being able to retrieve or review the results. Because of the granular design of the application, customer requests for changes and additional access can be quickly and easily handled. Allowing customers to connect to the laboratory application would require no additional licenses or database connections. Customers

could have on-line access to their results and reference information for research purposes. Customers would be able to download their results on-demand. If a customer agrees to retrieve information on-demand or receive information automatically via e-mail, the resources for printing or faxing are eliminated completely. By working directly with the customer, the laboratory can have advance information on samples to be analyzed and the customer can have access to the results as soon as they are posted. Customers would have access to tracking samples to know when they are received and when they are analyzed.

Summary: With Internet technology and an Internet-based application, the laboratory could support multiple locations anywhere in the world as one enterprise. Similarly, customers could access their information from anywhere in the world. The boundaries of geography can be effectively eliminated for customers as well. Sample turnaround and results reporting time can be reduced to the bare minimum. Responsiveness to customer requirements and changing operational needs can also be improved. The implementation of Internet/Intranet technology can provide significant enhancements to the laboratory operation and customer relations. The costs of implementing the necessary infrastructure is minimal when there is an existing network. The value of providing connectivity to the Internet is small in comparison to the capabilities offered by such connectivity. Laboratories can grow beyond their physical boundaries and develop partnerships with other facilities to provide a greater scope of customer coverage. Internet technology will provide the means for laboratories to enhance the systems they have and expand their horizons to accommodate the needs and wishes of tomorrow.